Ocean Data Telemetry Microsat Link (ODTML)

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LONG-TERM GOALS

The long term goal of this program is to have a world-wide real-time ocean monitoring system, which will service all ocean data platforms. This system will consist of three components, being developed in unison under three different contracts. The components are: 1) the Spacecraft Communications Payload (SCP), 2) the Ground to Space Communications Terminal (GSCT), and 3) the Network Control Center (NCC). The contracts are: Ocean Data Telemetry Microsat Link (ODTML), N00014-C-0276; TacSat-3 and -4 Spacecraft Communications Payload, N00014-06-C-0349; and Ground to Space Communication Terminal, N00014-07-C-0525.

OBJECTIVES

The culmination of this work will result in a robust, cost-effective two-way (space-to-ground and ground-to-space) satellite system with significant increases in the amount of data that can be collected from autonomous platforms. Of primary importance is a two-way delay-tolerant messaging capability providing Internet-like services on a global basis. The ODTML architecture will allow evolution and expansion for future sensors, and it will decouple platform (buoy) upgrades from future space segment system upgrades. Thus, new technology will be able to be introduced seamlessly into either the sensor grid or the satellite system. This work is developing a cost-effective constellation of space payloads (SCPs) and ocean platforms (GSCTs) to meet the DoD (and civil sector) needs for a real-time Integrated Ocean Observing System, and general purpose data exfiltration/infiltration system. The U.S. Navy will be the direct beneficiary of the system, as it will enhance the Navy's ability to gather sensor information on a global and near real-time basis, by interrogating and tasking ocean observing platforms. Such capability has applications in the area of anti-submarine warfare, surveillance, and other ocean-monitoring activities.

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APPROACH

Our approach is to design, develop, demonstrate, and test an engineering development unit of the ODTML system (Figure 1). The ODTML network system, consists of the following elements: a microsatellite SCP (serving as a "router in the sky"), ocean observing platforms (e.g., free-floating buoys) equipped with GSCTs for the RF link to the SCPs, and ground stations acting as gateways to the Internet with the NCC as the system manager. The NCC will apply the concept of IP addressing of sensor nodes and Internet-based "instant messaging," to create a network out of the traditionally inefficient ocean monitoring platforms and the associated communications relay system. The users will be able to interrogate and task a number of ocean monitoring platforms, gather geographically distinct measurements nearly simultaneously for an extended period of time, and thereby acquire an improved awareness of the target environment. Sensor network technology allows near real-time exchange, which includes node-to-node type (when nodes are within line-of-sight of each other) and node-to-relay (when nodes are beyond line of sight from each other). The stand-off distances can be in tens to hundreds of kilometers. Data transmission rates can range from 1200 to 9600 bps.

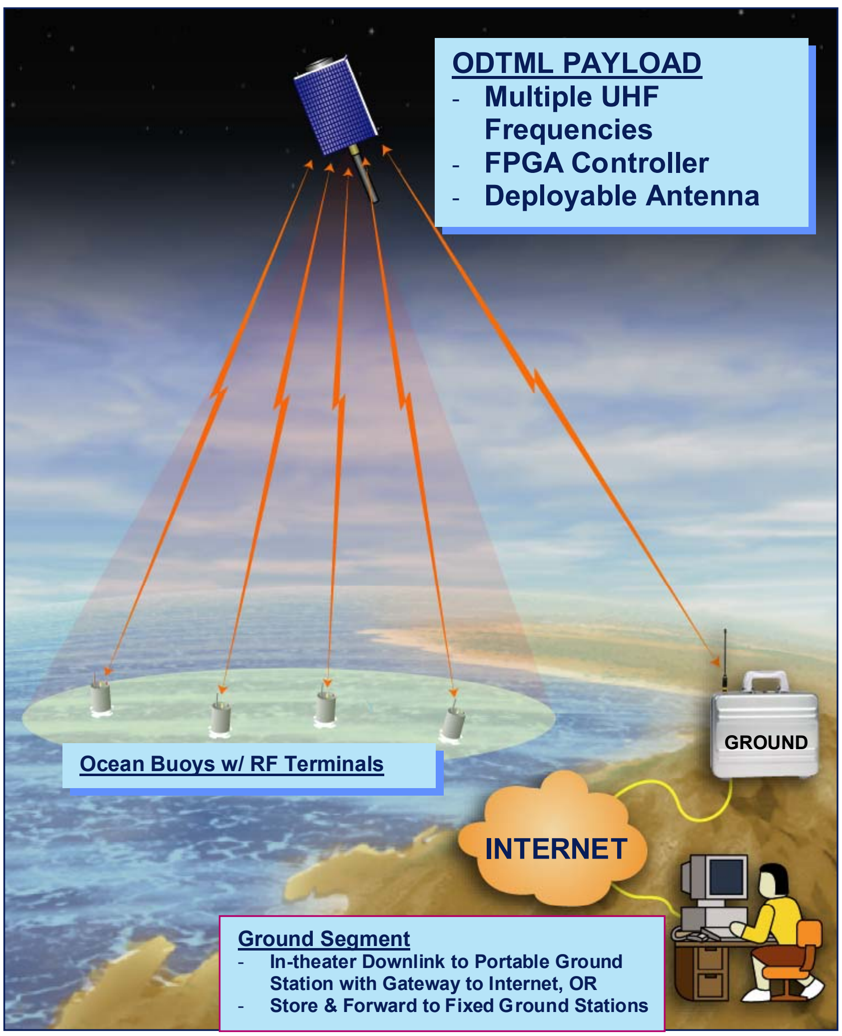

Figure 1. Ocean Data Telemetry Microsat Link System Architecture (ODTML)
[ODTML consists of RF terminals (GSCTs) on ocean buoys, a payload on a microsatellite (SCP), and a portable ground station connected to the internet for tasking and data dissemination (NCC)]

Praxis has designed, built, and delivered a low cost, low power, space qualified, two-way communications payload for flight on the TacSat-3 spacecraft (FY08 launch). This payload is the first generation version of the SCP, a concept originally envisioned in ONR SBIR, N02-062, Ocean Data Telemetry MicroSat Link, and uses a Commercial Off-The-Shelf (COTS) RF transceiver, furnished by SpaceQuest, Inc., and a custom built quadrifilar antenna. This payload, built by Praxis in conjunction with Silver Engineering, Inc., will provide data exfiltration/infiltration capabilities via the Internet for ocean buoys and other low data rate sensors, once it is launched in Q4 FY08.

Praxis has developed a miniaturized ocean buoy RF terminal, known as the GSCT. This terminal is small (2" x 3"), low power, smart (onboard processor), and low cost. Praxis is planning on building several dozen of these GSCTs and placing them on ocean buoys and other platforms of opportunity. The small size and low cost of this terminal will allow proliferation of these sensors around the world, providing a great opportunity to demonstrate the utility of the ODTML architecture.

In addition, Praxis is developing an NCC to completely manage the ODTML system. The NCC will furnish a world wide web interface for users to utilize the ODTML system. The NCC paradigm of operation will be a TPPU (task, post, process, utilize) as opposed to the old TPED (task, process, exploit, disseminate) methodology. In the TPED architecture, the producer of data processes and exploits the data before disseminating the results to other users he or she thinks should know about his data. In the TPPU paradigm, the producer of data posts the raw data as well as every interim solution so that everyone who needs it can pull it into his own evaluation process.

The ODTML architecture allows evolution and expansion for future sensors, while maintaining backward compatibility with all existing data systems. It decouples platform (buoy) payload upgrades from future space segment system upgrades. Thus, new technology will be able to be introduced seamlessly into either the sensor grid or the satellite system. Because of the modularity, small size, low power, and ease of installation, the SCP will be capable of integration on many different space platforms. (It has already been manifested on two additional spacecraft, TacSat-4 and STPSat-2, which are scheduled to launch in FY 09.) Similarly, because of its small size and low cost, the GSCT will be able to be installed on a plethora of sensor platforms. Finally, the NCC will allow seamless dissemination (TPPU) of the data. Thus, ODTML will move the U.S. Navy closer to the goal of persistent monitoring and having an integrated global ocean observing system.

WORK COMPLETED

(1) Refined and finalized an SCP to TacSat-3 ICD, integrating the changes into the ODTML architecture and documenting them in the Systems Description Document (SDD).

(2) Completed the design and build of an SCP for flight on the TacSat-3 spacecraft.

(3) Performed EMI/EMC testing of the SCP.

(4) Performed thermal vacuum testing of the SCP.

(5) Performed flight acceptance random vibration testing of the SCP.

(6) Held Flight Readiness Review (FRR) and shipped the SCP to AFRL for integration onto the TacSat-3 spacecraft.

(7) Specified, designed, and built the prototype GSCT.

(8) Wrote a Network Control Center development plan.

(9) Developed the capability to downlink directly to a PRC-117 man-portable radio for use by the Army Space Battle Lab.

(10) Performed an end to end test of the SCP to PRC-117 link.

RESULTS

Praxis has completed the first SCP for flight on the TacSat-3 spacecraft, and has built the first prototype for the GSCT. In addition, Praxis has defined the requirements for the NCC.

Praxis completed the base period SBIR Phase II effort in FY06. Under the SBIR Phase II effort, Praxis was required to design, develop, demonstrate, and test an engineering development unit of the ODTML system. All of the tasks were completed as described in the ODTML Phase II Base Final Report. Based on the successful completion of all Base period tasks, we were asked to proceed with all three tasks of the Phase II Option effort, which completed the design and build of an SCP flight unit, and prepared it for a field demonstration on the TacSat-3 spacecraft. On a separate contract, we were tasked to build several dozen GSCTs for placement on a variety of platforms to allow a robust demonstration of the ODTML capabilities.

IMPACT/APPLICATIONS

This work is a giant step toward the deployment of an ODTML system capable of persistent surveillance of ocean sensors through the use of a constellation of cost effective, space qualified SCPs and GSCTs. ODTML will meet the DoD (and civil sector) needs for a real-time Integrated Ocean Observing System. The U.S. Navy will be the direct beneficiary of the system, as it will enhance the Navy's ability to gather sensor information on a global and near real-time basis by interrogating and tasking ocean observing platforms. Such capability has applications in the area of ASW, surveillance, and other ocean-monitoring activities. An ancillary benefit would be the ability to also monitor other data sensors, such as unattended ground sensors and Low Probability of Intercept (LPI) communication devices. In fact, once a system is in place, it could be used for data exfiltration from a host of different data terminals.

The ability to provide near real-time situational awareness is essential for the next generation ocean observing system because the response time to an occurring event, military or scientific, is increasingly tied to operational effectiveness. The ability to query or interrogate a sensor that has detected an event is important because users often desire confirmation or more frequent observation of the event. Current systems do not meet these needs because they are based on dated technologies.

A major achievement of this program will be the increased intelligence value realized by being able to network a group of individual sensors into a grid of smart, cooperative nodes. With on board processing, smart sensor nodes will evaluate gathered data and make knowledge-based decisions on whether to notify other sensors or query them on their information. In other words, they will become a team, sharing data and helping each other to know either what has happened or what to expect. Data fusion, data sharing, and data queuing are all new capabilities that will be introduced by this concept of networking smart sensors. This will greatly enhance the intelligence value of the sensor grid over having individual sensors unable to communicate.

TRANSITIONS

None.

RELATED PROJECTS

Spacecraft Communications Payload (SCP) for ONR Swampworks Office. The SCP program will build a payload to fly on the TacSat-3 spacecraft. The SCP payload will be the router in the sky for the ODTML system of data buoys. It will be the communications hub for the entire system envisioned in the ODTML SBIR. This proposal will enable an operational evaluation of the present payloads (Aprizesat payloads), and the improvement of any shortcomings identified in this demonstration, thus resulting in an enhanced SCP.

Smart Sensor Node (SSN) In House (Praxis) R&D Effort. To evolve to this “smart” sensor goal, Praxis undertook an in-house effort to design a small, low cost RF terminal with a CPU and a DSP to increase the processing capability of terminals to allow on-board data fusion. These SSNs are now more than just dumb data terminals, and being able to process and share data allows them to react to detected data and queue other buoys based on the detected event, greatly enhancing their overall effectiveness.

Integrated Sonobuoy Advanced Networking (ISAN), NAVAIR SBIR N03-189. This SBIR’s objective was to develop a system design and feasibility concept for an integrated ocean data collection system. Central to this design was the SCP acting as a “router in the sky” communicating with smart sensor nodes. Praxis defined requirements for a SCP that could fly on either an aircraft or a spacecraft.

TacSat Program. The Office of Force Transformation (OFT) started the TacSat program in 2003, and has passed its program management on to AFRL. This program is looking for fast turnaround, low cost payloads to fly to demonstrate that space doesn’t have to “cost too much and take too long.” NRL built TacSat-1 and AFRL is building TacSat-2 and TacSat-3. TacSat-2 is nearing completion and TacSat-3 is in the planning stage with a projected launch date of 17 October 2007. Our schedule for the SCP will allow us to meet that date.

OFT Standard Bus Program. OFT has funded AFRL and NRL to come up with a generic bus design to be used for TacSat-4 and beyond. The SCP is likely to be manifested on future TacSats because of its small size and low cost.

DoD Space Test Program. This is a DoD program that funds I&T costs for payloads to fly in space. Each year a competition is held and payloads are evaluated, and an attempt is made to match payloads with available space rides. ODTML was ranked in the 2004 SERB, and the SCP is built and manifested on TacSat-3. STP will furnish the funds to integrate it onto the TacSat-3 spacecraft.